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Dynamic Wildfire Risk Mapping: Challenges and Solutions

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Dynamic Wildfire Risk Mapping: Challenges and Solutions

2006 ESRI User's Conference

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Dynamic Wildfire Risk Mapping

- Introduction
- Approaches to Modeling Fire
- Current Research
 - VESTA
 - Fire Information Engine
- Future Directions of Fire Modeling

Wildfire Stats

- ~ \$1 Billion / Year
- > 50,000 Fires
- > 1,000,000 Acres
(Human-Caused)

2003 California Fires
Cerro Grande
Oakland Hills



Introduction

Domains:

- Human / Social
- Ecological
- Physical
- Environmental
- Climatological
(Climate Change)

Approaches:

- .History (Ecological)
- .Risk / Hazard (Sociological)
- .Spread (Mechanistic)
- .Dynamics (Physics)

Introduction

At What Scale, Fire?

Fine scale

- Meters-Kilometers, Minutes-Hours, People

Continental scale

- States, regions, Seasons – Centuries,

Civilizations

Behavior, Risk, Spread, and Dynamics

Current Approaches

Ecological:

Fire Regime Analysis

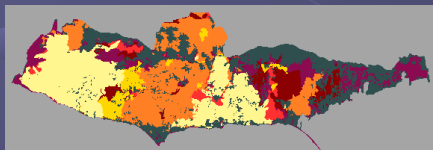
Succession Patterns

LANDIS-II

Remote Sensing

Burn Histories

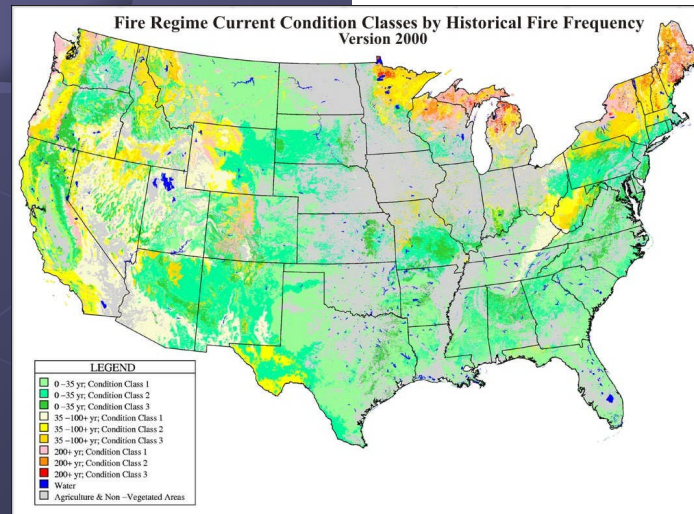
Landscape-scale Dynamics



Santa Monica Mountains Stand Maturity

Stand Age, Including Areas
Replaced By Urbanization

- 0 - 9 Years Maturity
- 10 - 15 Years Maturity
- 16 - 20 Years Maturity
- 21 - 29 Years Maturity
- 30 - 43 Years Maturity
- 50 - 74 Years Maturity
- Urbanized Areas
- No Data



LEGEND

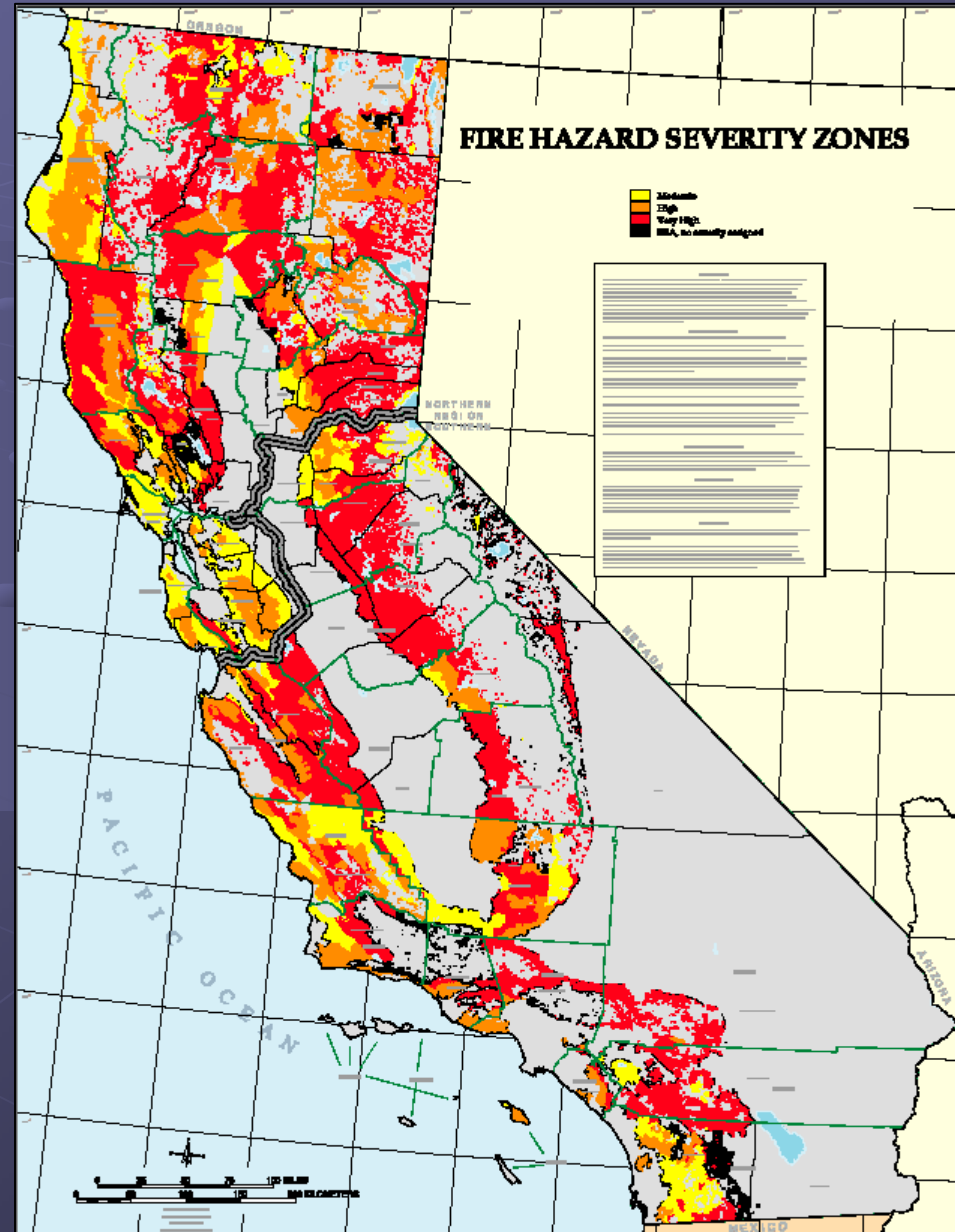
- 0 - 35 yr; Condition Class 1
- 0 - 35 yr; Condition Class 2
- 0 - 35 yr; Condition Class 3
- 35 - 100+ yr; Condition Class 1
- 35 - 100+ yr; Condition Class 2
- 35 - 100+ yr; Condition Class 3
- 100+ yr; Condition Class 1
- 100+ yr; Condition Class 2
- 100+ yr; Condition Class 3
- Water
- Agriculture & Non-Vegetated Areas

Current Approaches

Sociological:

Wildfire Risk

Wildfire Hazard



Current Approaches

Mechanistic, Deterministic Spread:

Rothermel Equations (1972)

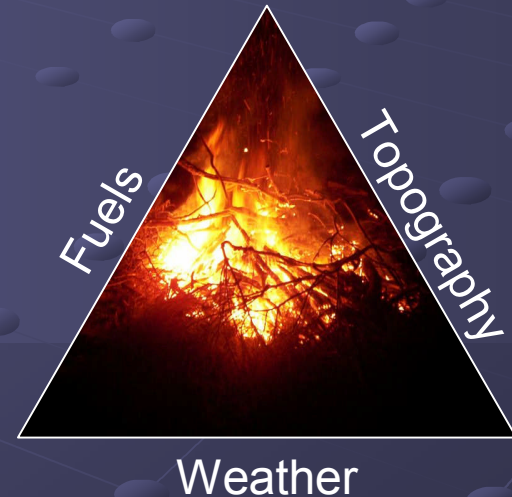
Fire Behavior Triangle

Other Parameters:

Fuel Moisture

Fuel Type

Ignition Intensity



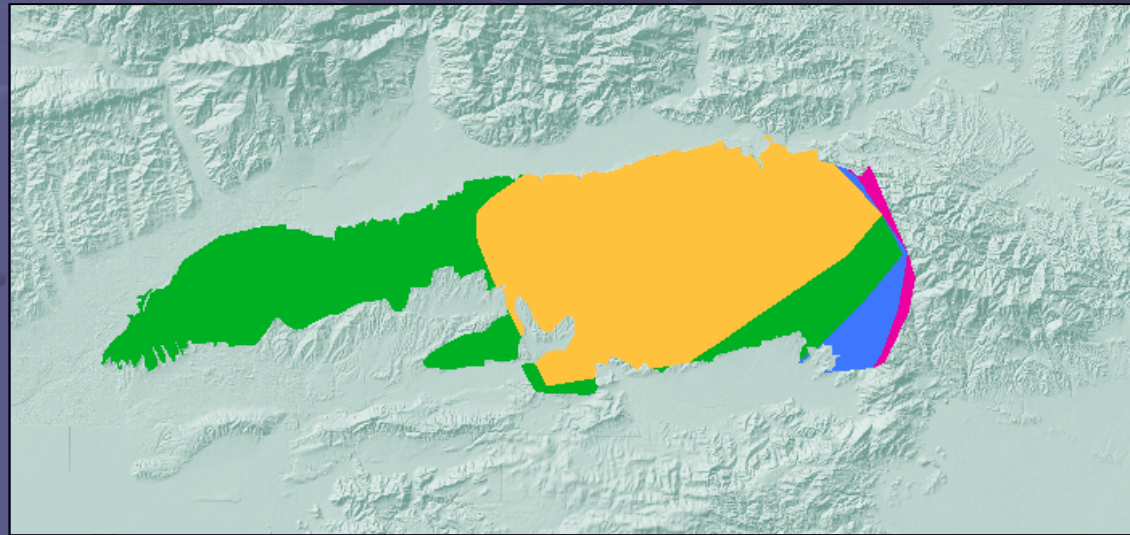
Current Approaches

Mechanistic, Deterministic Spread:

BehavePlus

FARSITE

HFire

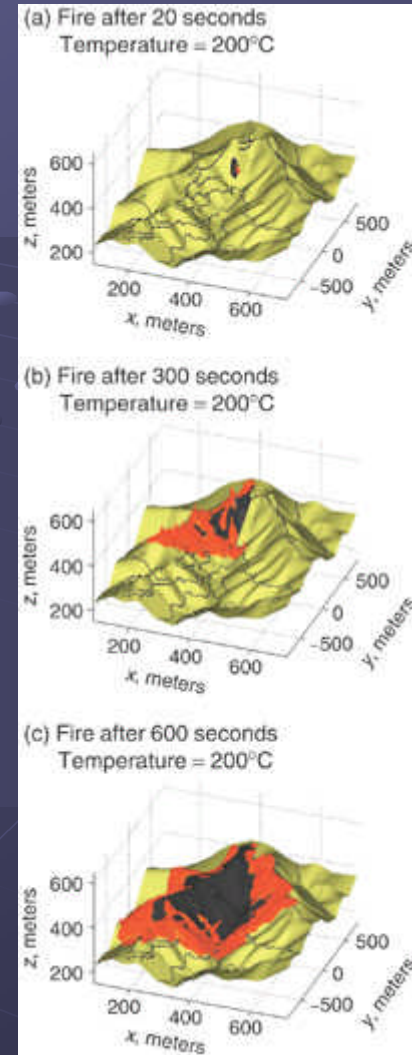
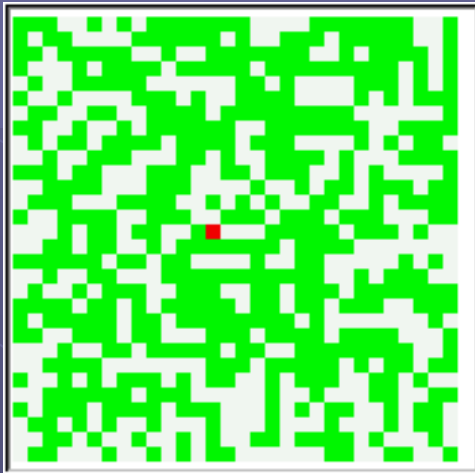


2003 Simi Fire: 10 days,
\$10 Million, > 100,000 Acres

Current Approaches

Physics – based (Dynamics):

- IBM (ABM) or CA- based models
Explore Power-law relationships
- FIRETEC Full Physics Coupled
Atmospheric Model



~~Current Approaches~~

Extant Approaches are not *dynamic*:

- Weather
- Human Behavior
- Policy
- Vegetation
- Fire Fighting

No one model incorporates all of these

Dynamic Wildfire Risk Mapping

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- **Current Research**
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- Future Directions of Fire Modeling

VESTA

● Decisions of Land Use & Fire Management

- Made in isolation
- Short-term vision

SLEUTH + Wildfire *Risk* Model = VESTA

● Why Risk?

- Probability
- Common Denominator
 - Allows cross-walking between models
 - Appropriate time scale

The SLEUTH Model of Urban Growth

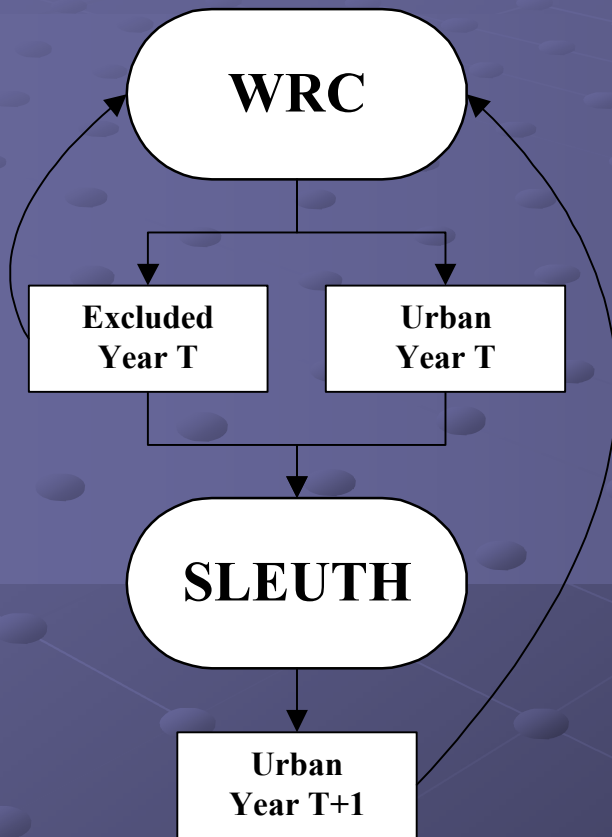
Developed By Clarke et al

SLEUTH: Slope
Landuse
Excluded
Urban
Transportation
Hillshade

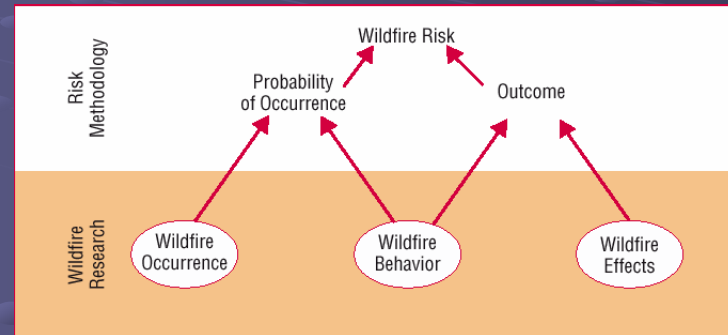


Wildfire Risk Component

Data Flow in Vesta



$$P(\text{burning}) = r = \mu \times \rho$$



Bachmann & Allgower, 2001

For a given year, if $P(\text{burning}) > X$,
cells are “burnt”

Wildfire Risk Component Data

Factors of μ (occurrence)

- Topography

- Weather

- Distance to:

- Fuels

- Ignition

- Roads

- Wildland Urban Interface (WUI)

Factors of ρ (outcome)

Landuse:

Natural Veg (High)

Urban (Medium)

Road (Zero)

Modeling Santa Barbara



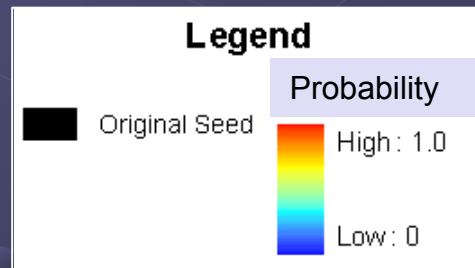
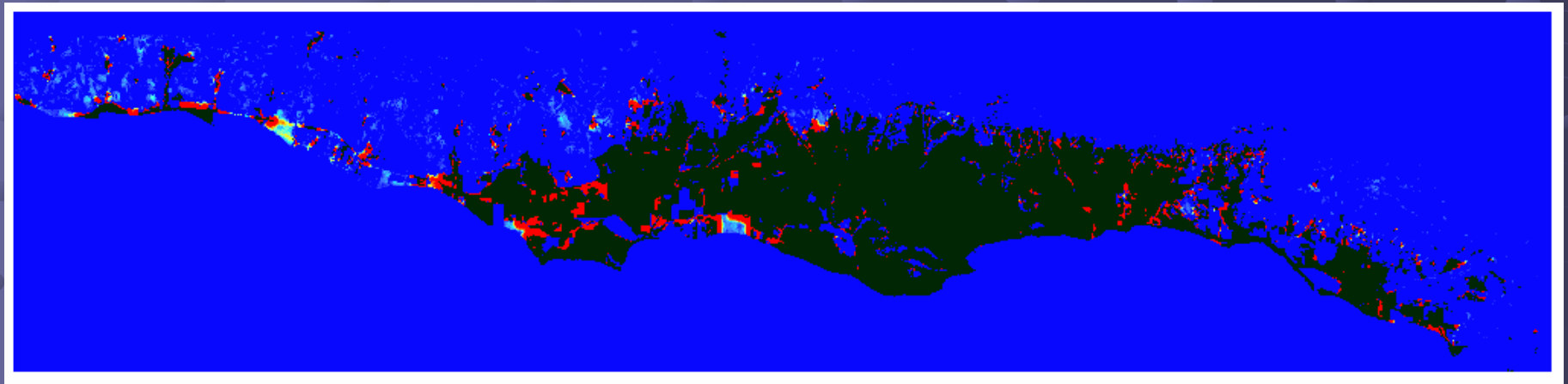
Los Padres National Forest

Santa Barbara in 2020

Santa Barbara Vesta

Modeling

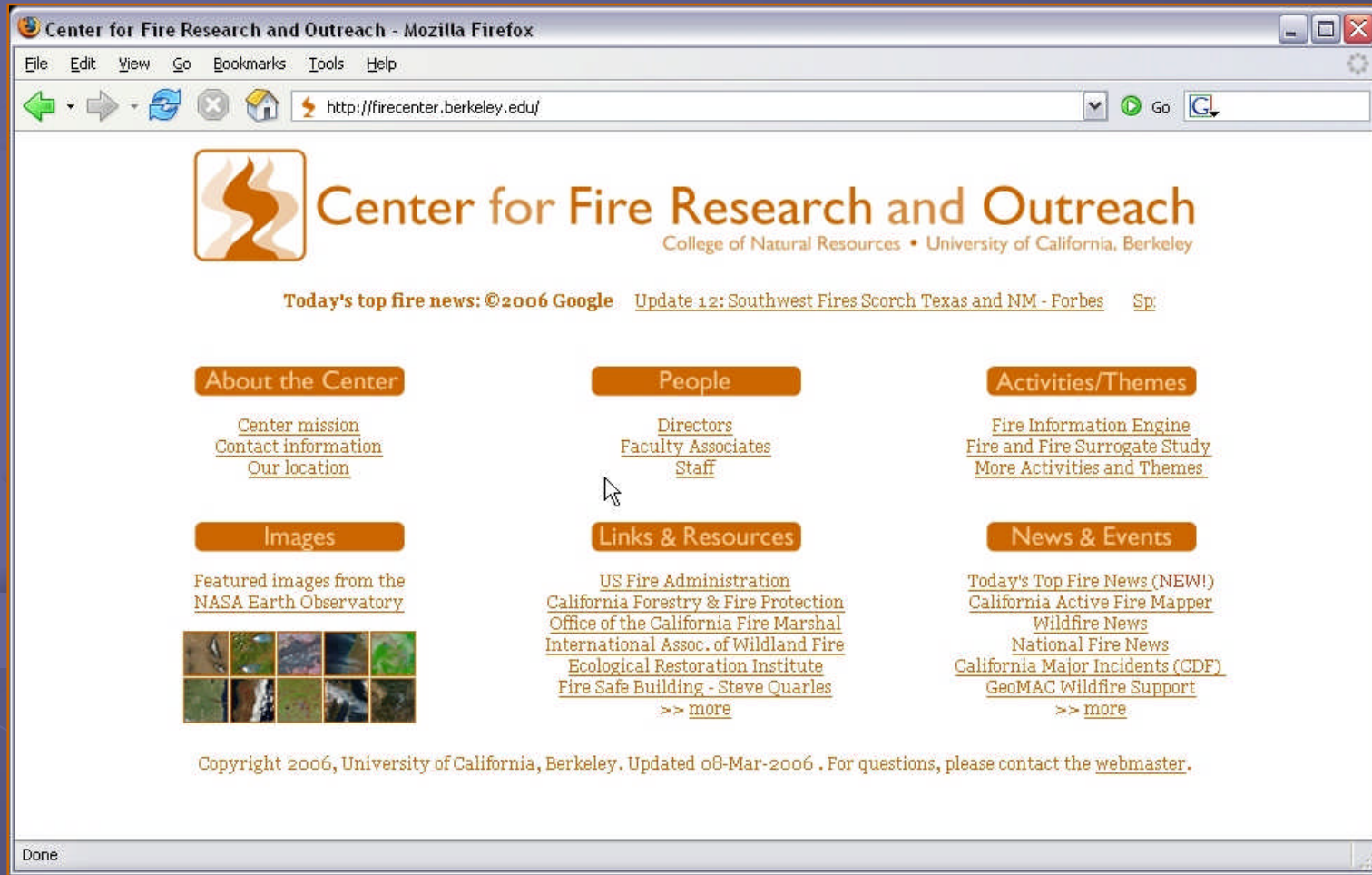
● Growth forecast to 2020



Vesta Conclusions

- Adaptation to high risk leads to:
 - Lower Wildfire Risk
 - Reduced Urbanization
- Global and local policy changes
 - Vesta as a policy tool
 - Vesta as an analytic tool (past & future)
- Defensible Space
- More data parameterization

Current Research & Collaboration



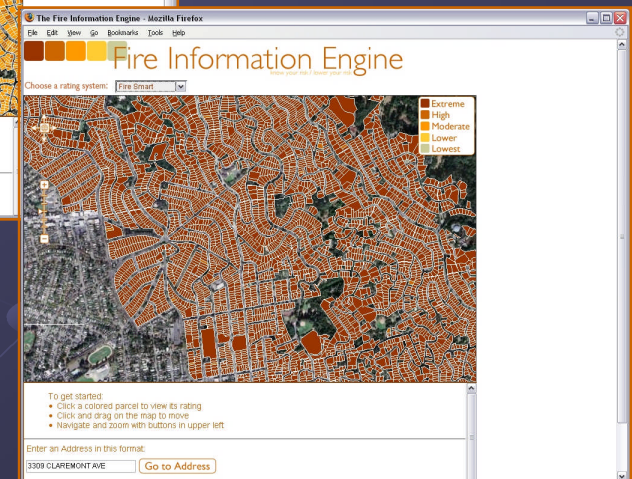
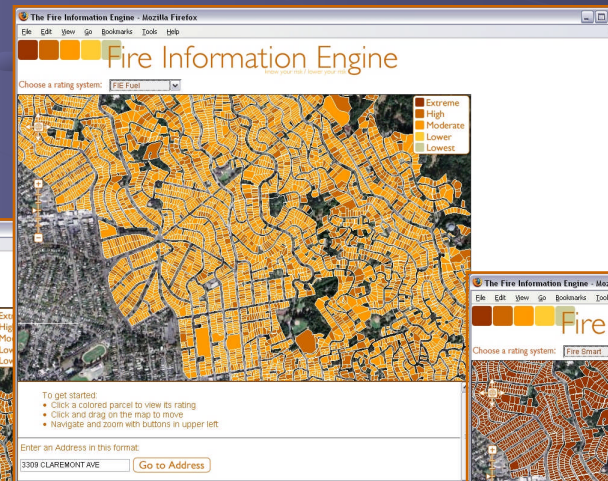
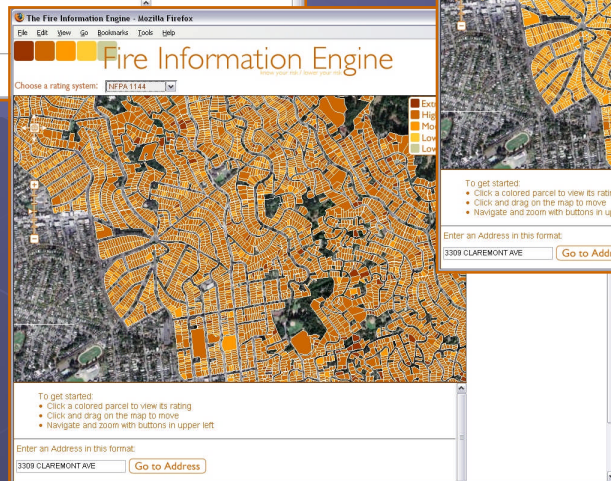
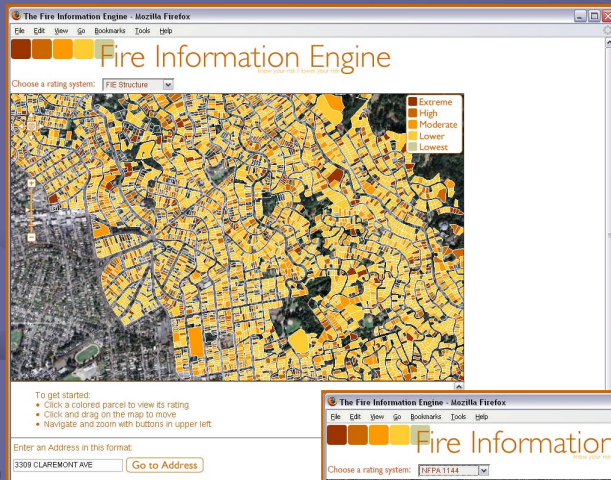
firecenter.berkeley.edu

Established at the University of California, Berkeley with financial support from the University and the Department of Homeland Security

Current Research & Collaboration

● Wildfire Risk Mapping

- Comparative Strategies for Local Citizens



Zoom in and click to get parcel level “report card” that lists fire hazard rating – focus on interpretation of results.

WUI Fire Hazard Report Card - The Fire Information Engine - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

WUI Fire Hazard Report Card

Street address: 2122 LOS ANGELES

Overall rating: Lowest

Structure Rating Site Fuels Rating Suppression Rating

- Extreme Hazards
- High Hazards
- Moderate Hazards
- Lower Hazards
- Lowest Hazards

Currently developing materials that will focus on for suggestions for improvement – including time, cost, etc.

WUI Fire Hazard Report Card - The Fire Information Engine - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

WUI Fire Hazard Report Card

Street address: 2122 LOS ANGELES

Overall rating: Lowest

Structure Rating Site Fuels Rating Suppression Rating

Extreme Hazards

Hazards That Apply to Your Parcel:

- None Apply

Hazards Not Observed But May Apply to Your Parcel:

- None Apply

High Hazards

Hazards That Apply to Your Parcel:

- None Apply

Hazards Not Observed But May Apply to Your Parcel:

- Roof condition: a roof should be in good structural condition with no gaps or openings on the roof or in or near the roofline. Openings in tile roofs should be blocked or screened. Openings in or near the roof can allow embers, flames, and radiant heat

Moderate Hazards

Hazards That Apply to Your Parcel:

- None Apply

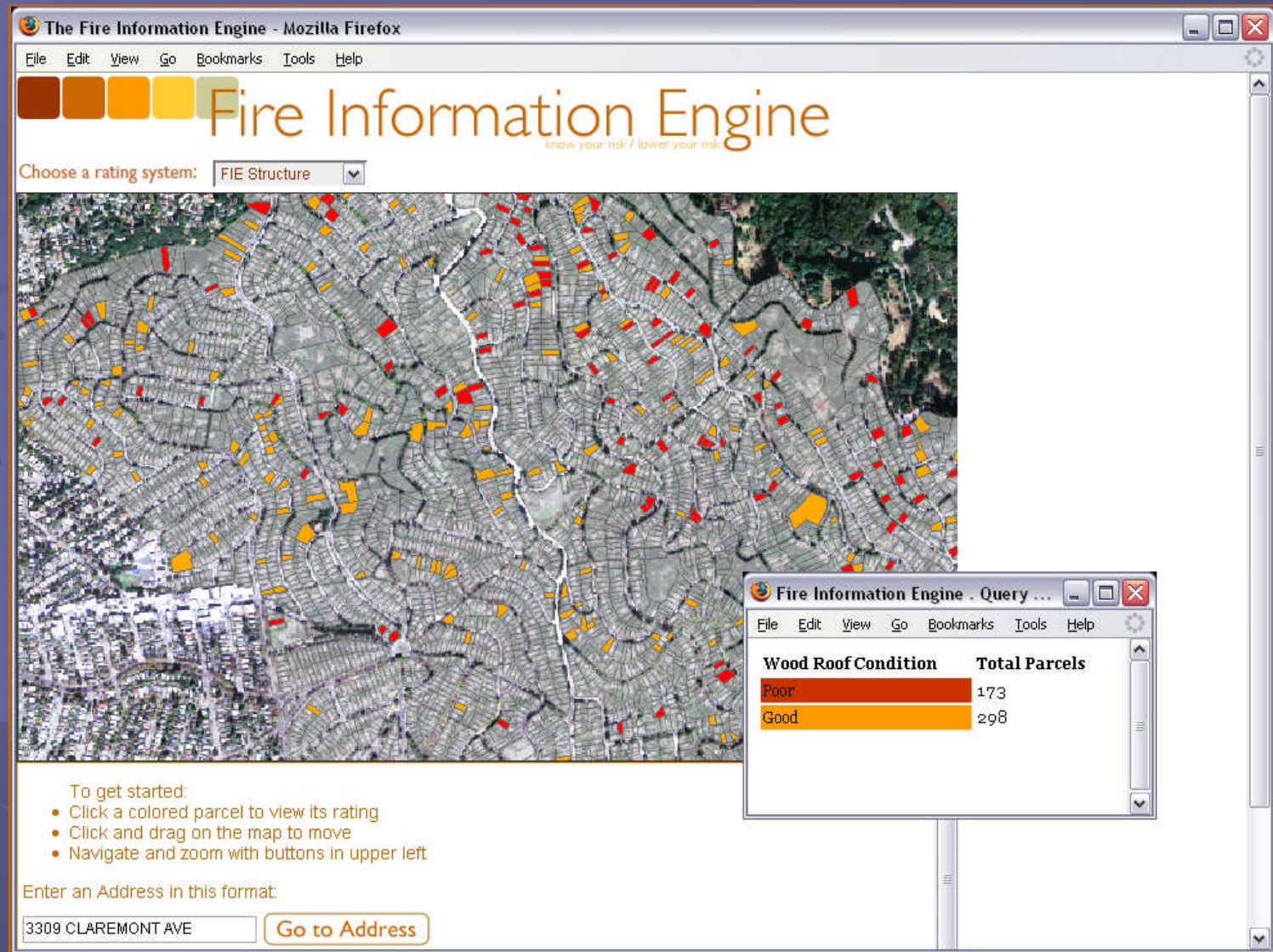
Hazards Not Observed But May Apply to Your Parcel:

- Vent materials: vents should be made of fire resistant or non-combustible materials.
- External door gaps can allow embers and flames to enter and threaten the structure.

Lower Hazards

Lowest Hazards

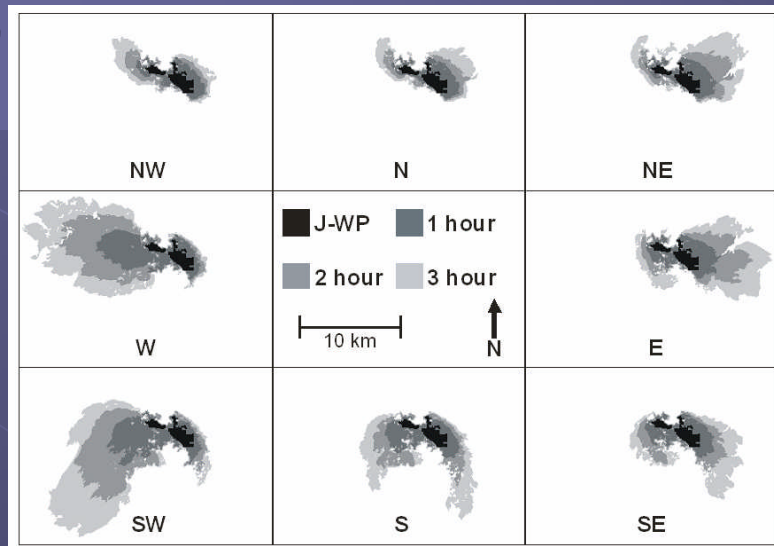
Tools for Decision-makers



Example: Locate all wood roofs in poor condition to explore the implications of a roof rebate program.

Future Directions of Fire Modeling

- Integration with other GIS
- Hand-held tools
- Real-time modeling
- Evacuation Modeling



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